IMPROVE OF DESIGN AND ANALYSIS OF HYDRAULIC HOUSE FENCE OPENING USING TAP WATER PRESSURE

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in fulfillment of the requirement for the degree of
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2017

DECLARATION

I declare that this project report entitled “Improve of Design and Analysis of House Fence Opening” is the result of my own work except as cited in the references

Signature : .....

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Date : 12th JULY 2017

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Design & Innovation).

Signature :. .....

Name of Supervisor : DR. MOHD BASRI BIN ALI

Date : 12th JULY 2017

DEDICATION

To my beloved mother and father

ABSTRACT

This thesis discussed the improvement of design and analysis of house fence opening. The objectives of this thesis are to improve the design for existing hydraulic fence product, to fabricate the prototype, and to analyze and compare the capability of the improvement product. The main problem of existing product made is the cost and the previous researcher does not use automatic system to operate the fence movement. The cost can be divided into two categories, which is manufacturing cost and operating cost. The existing product need to operate using variety of manual valve. Next, method that have been used to solve this problem is started with finding all related information about the fence opening system. The information is taken from internet, books, journals, newspapers and thesis. Then, the House of Quality was used to identify the characteristic that need to improve and listed the specification in product design specification. In conceptual design, the process start with morphological chart to provide the analytical and systematic concepts. Five concept design was generated based on product design specification and one best concept have been choose using Pugh method. Concept 4 was selected based on reliability, cost and ease of replacement of the components. The selected design was simulated using FluidSIM software and the simulation works correctly according to design. From the result, the prototype was working and the system was controlled using automatic remote control to open and close the fence. The system operates with 30 kg fence with pressure of 33 psi.

ABSTRAK

Tesis ini membincangkan peningkatan reka bentuk dan analisis pembukaan pagar rumah. Objektif tesis ini adalah untuk memperbaiki reka bentuk produk pagar hidraulik sedia ada, untuk menghasilkan prototaip, dan untuk menganalisis dan membandingkan keupayaan produk pembaikan. Masalah utama produk sedia ada yang dibuat adalah kos dan penyelidik terdahulu tidak menggunakan sistem automatik untuk mengendalikan pergerakan pagar. Kos boleh dibahagikan kepada dua kategori, iaitu kos pengeluaran dan kos operasi. Produk sedia ada perlu beroperasi menggunakan pelbagai injap manual. Seterusnya, kaedah yang telah digunakan untuk menyelesaikan masalah ini bermula dengan mencari semua maklumat berkaitan dengan sistem pembukaan pagar. Maklumat ini diambil dari internet, buku, jurnal, akhbar dan tesis. Kemudian, 'House of Quality' digunakan untuk mengenal pasti ciri-ciri yang perlu diperbaiki dan menyenaraikan spesifikasi dalam spesifikasi reka bentuk produk. Dalam reka bentuk konseptual, proses bermula dengan carta morfologi untuk menyediakan konsep analitis dan sistematik. Lima reka bentuk konsep dihasilkan berdasarkan spesifikasi reka bentuk produk dan satu konsep yang terbaik telah memilih menggunakan kaedah Pugh. Konsep 4 dipilih berdasarkan kebolehpercayaan, kos dan kemudahan penggantian komponen. Reka bentuk yang dipilih disimulasikan menggunakan perisian FluidSIM dan simulasi berfungsi dengan betul mengikut reka bentuk. Dari hasilnya, prototaip berfungsi dan sistem dikawal menggunakan kawalan jauh automatik untuk membuka dan menutup pagar. Sistem ini beroperasi dengan pagar 30 kg dengan tekanan 33 psi.

ACKNOWLEDGEMENT

Alhamdulillah, appraises to Allah for His regards and bless, I able to accomplish my final year project. I am using this opportunity to express my gratitude to everyone that supported me throughout the course. I am thankful for my supervisor, Dr Mohd Basri Bin Ali, my second examiner, Dr Shafizal Bin Mat and my academic advisor, Mr. Mohd Nazim Bin Abdul Rahman for their aspiring guidance, invaluably constructive criticism and friendly advice during the thesis.

My deepest gratitude for my parents, Ayop Azmi Bin Abdul Rahman and Hamidah Binti Abdullah for supporting me in all aspects especially finishing my prototype. I also want to express my warm thanks to Faculty of Mechanical Engineering for giving enough information for finish this final year project.

Lastly, I would like to thank everyone that's involved in helping me finishing my final year project especially my fiancée and friends.

CONTENT

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATION

n.d.	No date
mm	Millimeter
V	Volt
m	Meter
RM	Ringgit Malaysia
n/a	Not available
kg	Kilogram
PSM	Projek Sarjana Muda
PSI	Pound per square inch

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Fence is one of design technology that help people to solve problem by adding barrier to cover the area needed. The main purpose of the fence is to protect and secure the place. Nowadays, the production of the fence does not only for security only, the fence need to have good aesthetic value, easy to operate and friendly user. In general, fence can be operating manually or automatically. For manual operating, it used men power to open and closed the door. It is not suitable for people that have pack schedule or need to rush for works. The automatic fence opening was invented to solve the problem and it also more safe to the user while opening the fence.

In 1974, the student in Toledo, Ohio was investing 100 dollars to build the companies of garage door and automatic gate system. This college student was most successful entrepreneurs when George Elbe make the advertisement on local newspaper, he wants to sell 13 automatic door openers. All the door had been sold and installed. According to the company philosophy, the company was focused on satisfaction and customer needs (D. Janbu,nd).

The theory of automatic gate or fence as shown in Figure 1.1 is very simple by pressing the open button, the signal is sent to the main circuit board and its allow the current flow pass through the motor or hydraulic pump to run and the gate will open. After the gate fully open, the motor will stop running and the gate will stop moving. The operation will be same when pressing the close button. The gate is used commonly at residential area as point of entry to a space enclosed by walls. It controls point of entry and exit (C.K. Primus et al,2015).

From the previous research, the source of power supply is from water pressure. The water supply is from Syarikat air Melaka berhad. The pressure and load of fence is related to each other because the pressure should be higher than the weight of the fence. The water pressure use to extend and retract the cylinder at the fence (M. Yusuf,2016)

Previous researcher emphasizing several important factors for using tap water in his project. The main factor is to increase safety awareness and improved the environmental protection by using the tap water. The water can reduce the pollution compared to hydraulic oil. The manufacturing cost also can be reduce because the manufacturer can replace the cost of hydraulic oil with tap water (M. Yusuf,2016).

In summary of previous researchers, they invented the most useful to assist the human work. The basic concept on the system is quite same but the component is different based on the design of the system. All the design have their own objective to produce the system to solve the problem.

This project was focused on producing the automatic fence that operates using water pressure source from water supply. The water supply is the low cost energy and it is usually having in all house in Malaysia. On literature review, the researcher was focused on device that can used for manufacturing the automatic system. The researcher also finds the information about the other automatic fence system and the type of fence in market.

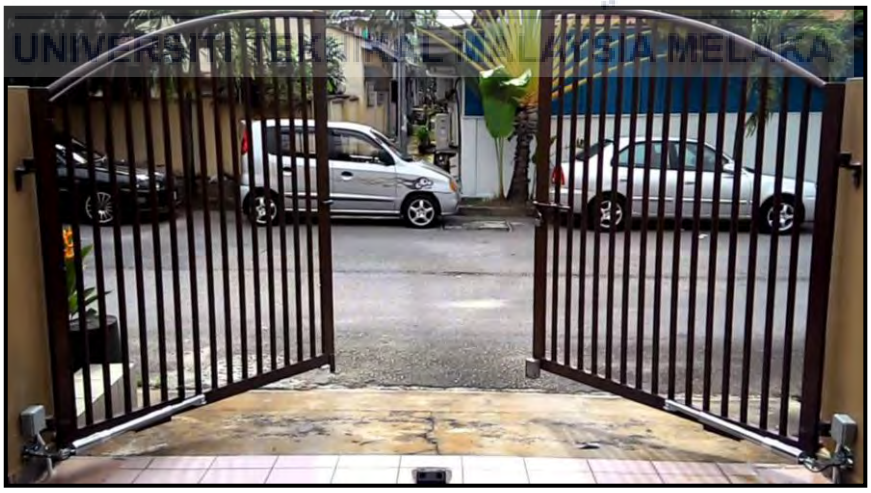


Figure 1.1: Swing automatic fence

(Source: autogate swing arm type,2013)

1.2 PROBLEM STATEMENT

The main problem of the existing product is the system does not used automatic system for opening and closed the fence. It need to closed and open the variety of valve to operate the fence. Each operation need to control two valve, which is one valve to control the release valve and another one valve to control the source of water as shown in Figure 1.2. It will increase the time to operate the fence and valve controller only can operate inside the house only as shown in Figure 1.3. The other problem with the existing fence is the cost. It is including the manufacturing cost and operating cost. The manufacturing cost is the cost when making the product including materials, labor and manufacturing overhead cost. The operating cost is including the source of power supply and it will be compare with electric and battery. To solve this problem, this project will improve the system by using automatic remote control to open and closed the fence.

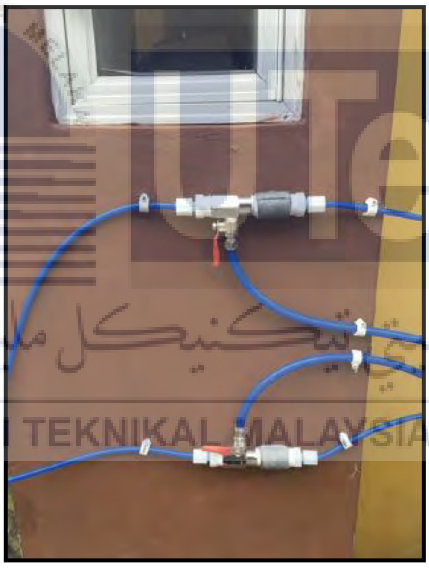


Figure 1.2: Control valve
(Source: M. Yusuf,2016)

Figure 1.3: Location of control valve

(Source: M. Yusuf,2016)

1.3 OBJECTIVE

The objectives of this project are as follows:

1. To improve the design for existing hydraulic fence product.
2. To fabricate the prototype of the hydraulic house fence opening.
3. To analyze and compare the capability of the improvement product.

1.4 SCOPE OF PROJECT

The scopes of this project are:

1. The improvement only included the swing type fence opening for terrace house.
2. Fabricate and install the new automatic system for fence opening.
3. The testing of the project also including the slide fence type for further research.

CHAPTER **2**

LITERATURE REVIEW

2.1 INTRODUCTION

The automatic fence is the popular technology that Malaysian peoples used for their home nowadays compared to manual fence. The main purpose of automatic fence is to assist human to open and close the fence for saving time and safety. The common automatic fence uses electrical system for control and generate power for movement. It is combine with mechanical system for moving the part, gear and linkage (M. Yusuf,2016).

In this project, the electrical system or battery as alternative energy source is only use for open and close the valve. The main energy is from pipe water pressure for moving the hydraulic system. The main purpose of this project is for improve the manual hydraulic system to automatic hydraulic system that using tap water. This project also to reduce the product cost and operating cost of automatic fence system.

2.2 TYPE OF FENCE

There are several type of fence that commonly used in Malaysia which is swing fence, slide fence, vertical lift fence, vertical pivot lift fence, and barrier arm fence. This project is focus on swing opening type fence only. The other type of fence is for guideline and finding the suitable type of fence that can use this system for further research.

2.2.1 Swing fence

The swing fence is divide into two type which is single and double swing fence opening. This type of gate is common use for home because it is easy to install and the cost is less than other type of fence. The fence can open inwards or outwards (M. Hagaman,2013). When the automatic system attach to this type of fence, the fence usually can open in one direction, either inwards or outwards.

Single swing gate usually 16 inch to 20 inch wide and it must have installed on a level flat plane for the fence driveway. The double swing gates can decrease the wide of the fence and it is having high aesthetic value compared to single swing fence (What are the Different Types of Driveway Gates,n.d.). The swing fence can hit the people or vehicle near the driveway when it is moving, so it need additional security system to prevent the it happen (M. Yusuf,2016).

Figure 2.1: Swing type fence
(Source: Sivakumar. S,n.d)

2.2.2 Slide fence

The slide gate use wheels to slide left to right or right to left depends on the space available for the fence driveway. The space needed for driveway must at least same as the width of the fence. There are three types of slide fence, it is V-track, rear pipe track and cantilever. The V-track is the most user choice of slide fence because it is being quite reliable. There is some problem with this type of fence when the track has some debris especially at snow and ice area. It also need 3 inch wider than

the opening of fence in order to save the space for installing the automatic gate system. The rear pipe track type is usually use with lower chain link fence. It also need 3 inch wider than the opening of fence for installation. For the cantilever type, it does not have any wheels on the ground. It can move on the driveway without care about the debris. The cantilever slide fence preferable especially in snow or ice area because the wheels is on the post of the fence (What are the Different Types of Driveway Gates,n.d.).

Figure 2.2: Cantilever slide type fence
(Source: Security/Fences/Gates,n.d.)

2.2.3 Vertical lift fence

In industrial application, the vertical lift fence always used to secure their place according to the cost. The fence is usually 8 inch tall and 16 inch wide and lift vertically above the vehicle. It is allowing the vehicle pass under the fence directly. The gate is the most secure fence compared to other type fence. For increase the aesthetic value, it can use any type of fence panel (What are the Different Types of Driveway Gates,n.d.).

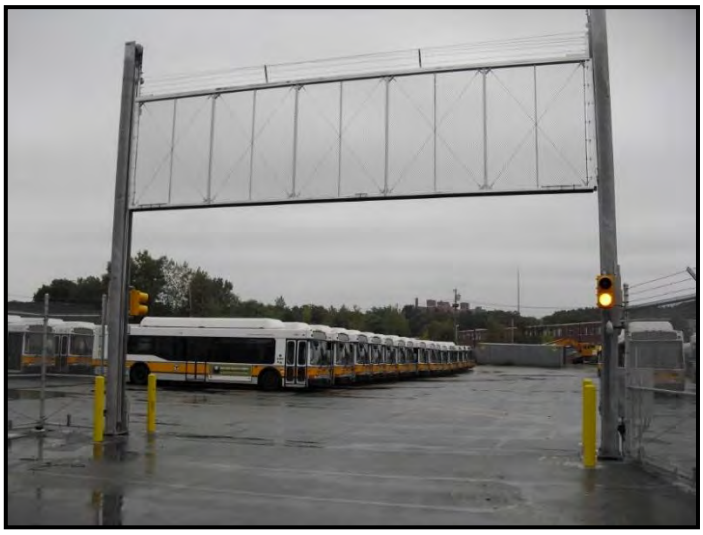


Figure 2.3: Vertical lift fence
(Source: unknown,nd)

2.2.4 Vertical pivot lift fence

The vertical pivot lift fence is supported only by the operators of the fence and it does not require any support to hold the fence. It will rotate in and out to open or close the fence opening. The Figure show the fence in open position (M. Yusuf,2016).

Figure 2.4: Vertical pivot lift fence
(Source: Vertical Pivot Gates & Automatic Gate Operators,n.d.)

The vertical pivot fence is suitable in small area place. If there is not enough space for swing or slide fence and the barrier fence does not enough security, the vertical pivot fence is best choice to solve this problem (What are the Different Types of Driveway Gates,n.d.).

2.2.5 Barrier arm fence

In general, the barrier arm fence commonly used in parking lots and garages. It is also in a lot of commercial application including airports or public facilities. This fence can operate manually by using man power. It also can be operated automatically by using card reader, keypad or telephone entry system (Selling the best in Electric Driveway Gates,n.d.)). Figure 2.5 shows the barrier arm fence with card reader access.

Figure 2.5: Barrier arm fence
(Source: Parking/Barrier Gates,n.d.)

The barrier arm fence is the efficient fence operator to reduce unwanted traffic due to the cost. This fence does not provide any security to secure the place (What are the Different Types of Driveway Gates,n.d.). The other type of fence should be considered to use if the place need high security

2.3 AUTOMATIC FENCE OPERATOR

The fence operator usually placed at the end of the fence to open and closed the fence by using mechanical device. The hydraulic or electromechanical usually been assist by electric system to operate automatically. The operator can be setup for open or close using wireless transmitter or using manual device. In emergency purpose, the automatic fence operator use solar power for generates energy when loss of electricity or blackout as shown in Figure 2.6.

Figure 2.6: Solar panel on operator
(Source: Solar Automatic Gate Operators,n.d.)

The mechanical fence operator need the fence to include with the leaf section and it will open one by one (Types of Automatic Gate Openers and Gates,2015). The mechanical component include in the system are gear operation, driven gear and shaft worm gear to rotate when opening the fence as shown in Figure 2.7.

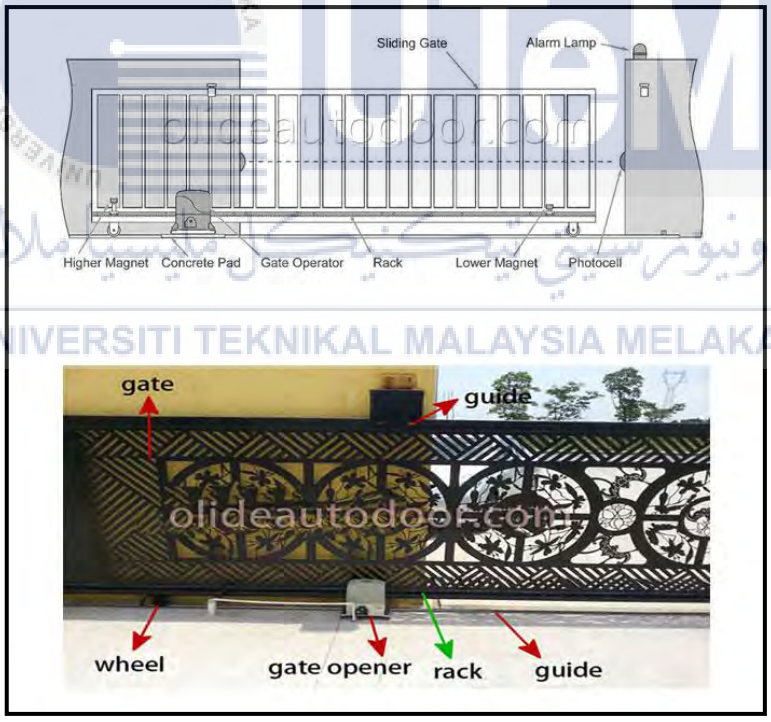


Figure 2.7: Mechanical fence operator components
(Source: Gear Rack Sliding Gate Opener,n.d.)

The hydraulic operator system use hydraulic fluid to make the motion. It usually use less component compared to mechanical system. The hydraulic system can operate more power to move the large fence. The main part of the hydraulic operator is the hydraulic cylinder as shown in Figure 2.8.

Figure 2.8: Hydraulic cylinder
(Source: Hydraulic Gate Closer,n.d.)

2.4 AUTOMATIC FENCE COMPONENTS

The components are focus on the automatic hydraulic component due to this project to have low cost automatic fence opening system. The component are cylinders, control valve, pressure relief valve, digital remote control switch, power supply, hose and valve.

2.4.1 Cylinders

There are two types of cylinders that need considered in this project which are double acting cylinder and single acting cylinder with spring return. This double acting cylinder as shown in Figure 2.9 contains one piston and piston rod assembly. The stroke of the piston and piston rod assembly in either direction is produced by fluid pressure. The two fluid ports, one near each end of the cylinder, alternate as inlet and outlet ports, depending on the direction of flow. This double acting cylinder will attach to fence to produce movement (Deheve, K. (n.d).

Figure 2.9: Double acting cylinder
(Source: Pneumatic cylinder / double-acting,n.d.)

The single acting cylinder perform fluid energy at the one side of the piston only as shown in Figure 2.10 (Deheve, K. (n.d). To make the movement of the other side of piston, the spring will assist the movement when the pressure of the fluid side is release.

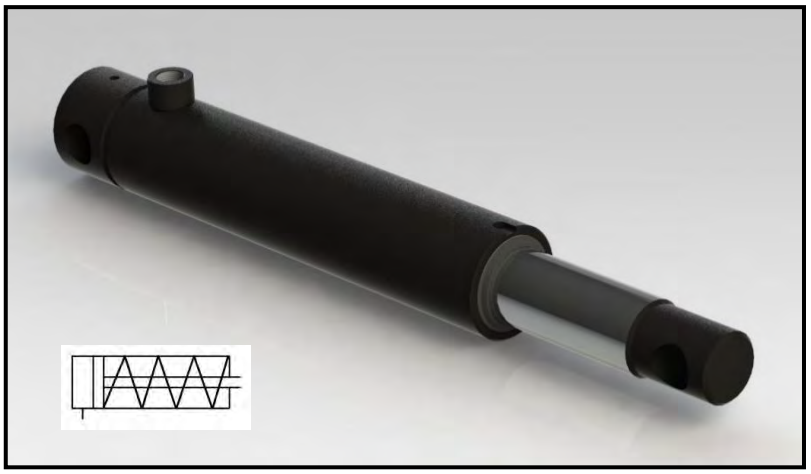


Figure 2.10: Single acting cylinder
(Source: Single Acting Cylinders,n.d.)

2.4.2 Directional control valve

Directional control valve as shown in Figure 2.11 is one of parts in hydraulic and pneumatic machinery. The function of this parts is allow fluid flow into different paths from one to more sources. It can control by using mechanically or electrically. Figure 2.12 shown the directional control valve connected to cylinder to control the extend and retract movement.

Figure 2.11: Directional control valve
(Source: unknown,n.d.)

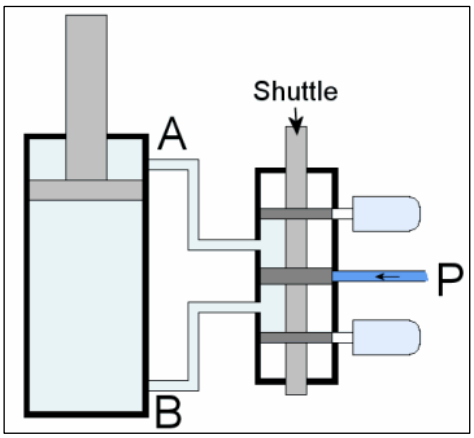


Figure 2.12: Directional control valve with cylinder
(Source: Directional control valves explained,n.d.)

2.4.3 Pressure Relief valve

Pressure relief valve as shown in Figure 2.13 is a safety device that active when pressure is higher than the pressure of the pressure valve. It is design to protect the equipment from damage when the pressure is high (Crosby Valve Inc,1997). For this project, the valve is to release the output fluid from the cylinder when the piston moves to other side.

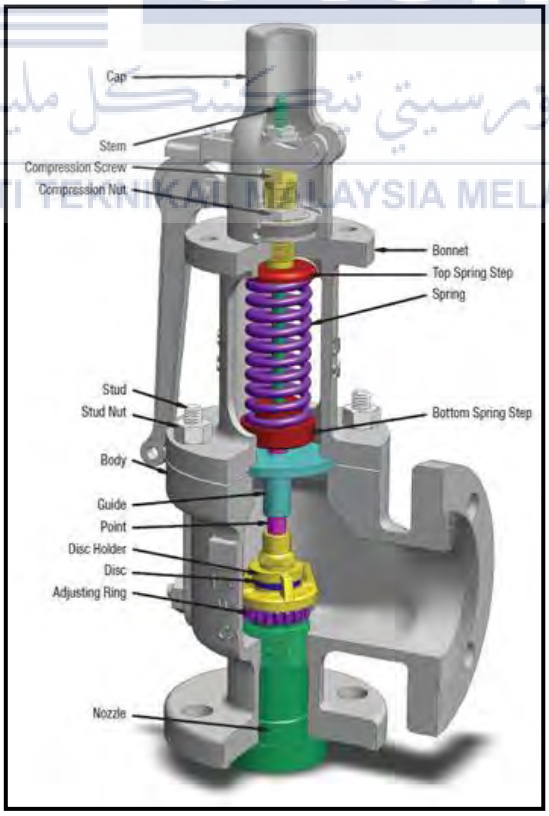


Figure 2.13: Pressure relief valve components
(Source: Safety Relief Valves,n.d.)

2.4.4 Digital remote control switch

The remote control switches as shown in Figure 2.14 controls the current flow using the remote and cut the current flow when the button was pressed for second time. It is to control the current for solenoid valve. It also allows to control with wireless system.

Figure 2.14: Remote control switch
(Source: 4 Channel Way Digital Remote Control,n.d.)

2.4.5 Power supply

A DC power supply as shown Figure 2.15 is one that supplies a voltage of fixed polarity (either positive or negative) to its load. Depending on its design, a DC power supply may be powered from a DC source or from an AC source such as the power mains. This power supply will have connected to solenoid valve to open the valve.

Figure 2.15: DC power supply
(Source: unknown,n.d.)

2.4.6 Hose

A hose is a flexible hollow tube designed to carry fluids from one location to another. The hose is 6 mm hose type as shown in Figure 2.16.

Figure 2.16: 6mm hose
(Source: Samco 6mm Silicone Vacuum Hose,n.d.)

2.4.7 Valve

A valve as shown in Figure 2.17 is a device that regulates, directs or controls the flow of a fluid (gases, liquids, fluidized solids, or slurries) by opening or closing. This valve for convert from normal size pipeline to 6mm pipeline.

Figure 2.17: Valve
(Source: unknown,n.d.)

2.4.8 12V battery

The function of the battery in this project is the alternative power supply for activate the solenoid valve. The solenoid valve need 12V voltage to active. The battery can be rechargeable for reduce the battery cost. Figure 2.18 shows the rechargeable 12V battery that can be use in this project.

Figure 2.18: 12V battery
(Source: 12 Volt 7 Amp Battery,n.d.)

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter is about the methodology of this project. The methodology flow will be explaining by flow chart that started with problem identification. Then, it follows with literature review for finding the related information. After that, continue with house of quality, product design specification, conceptual design and concept selection. After getting the best design, the design will be simulate using software and fabricate the product. The product will be analyse the performance. Lastly, report writing is the process of documenting all research works from beginning until end of the research.

3.2 RESEARCH METHOD

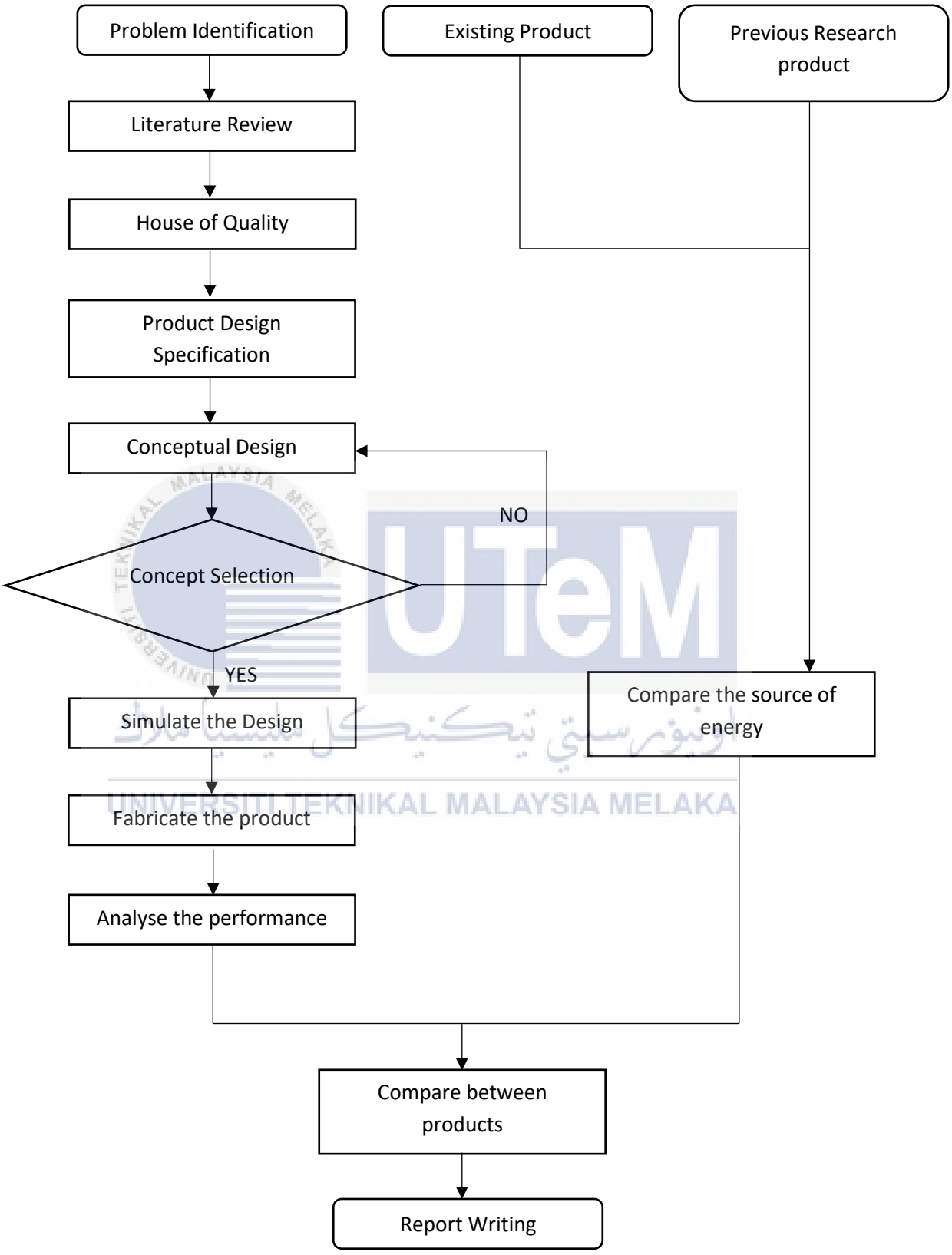


Figure 3.1: Flow chart

3.3 PROBLEM IDENTIFICATION

Problem identification is the first step for development of this project. From the problem, the researcher can identify the main criteria that need to improve. After getting the problem, the literature review helps for finding the information that related to the project. The information is collected from journals, articles, patent, books, thesis, and search through related websites.

3.4 HOUSE OF QUALITY

In house of quality, the customer requirement was listed and converted to engineering characteristic and then will be ranked to determine the important engineering characteristics that will be implemented to the design the project

3.5 PRODUCT DESIGN SPECIFICATION

Product design specification helps to find the facts related to final specification of product. All required specification will be list and fill according to this project.

3.6 CONCEPTUAL DESIGN

The conceptual design is the proses of design the concept based on specification of the product. 5 concepts had been design for evaluation in concept selection. For concept selection, Pugh method had been used to find the best design for proceed to develop.

3.7 SIMULATE THE DESIGN

Before developing of the project, the system need to be simulated using FluidSIM software to ensure all the component and design is correct. The process of simulation is shown in Figure 3.2 After the simulation is pass, the product will be developing and analyse of their performance. Then, the product will be compare to the existing and previous research product in cost and capability.

Figure 3.2 shows the process flow of using FluidSim. The process starts with sketh the initial design. The sketch can use any method and symbol depends on the designer. Then, after sketch, use the software to design the system according the design on sketch. Insert all components as per design. After that, it is ready to simulate the design. Check the result of the simulation. If the design works, the design is succesfull. If the result is fail or not working, back to sketching process to redesign the system.

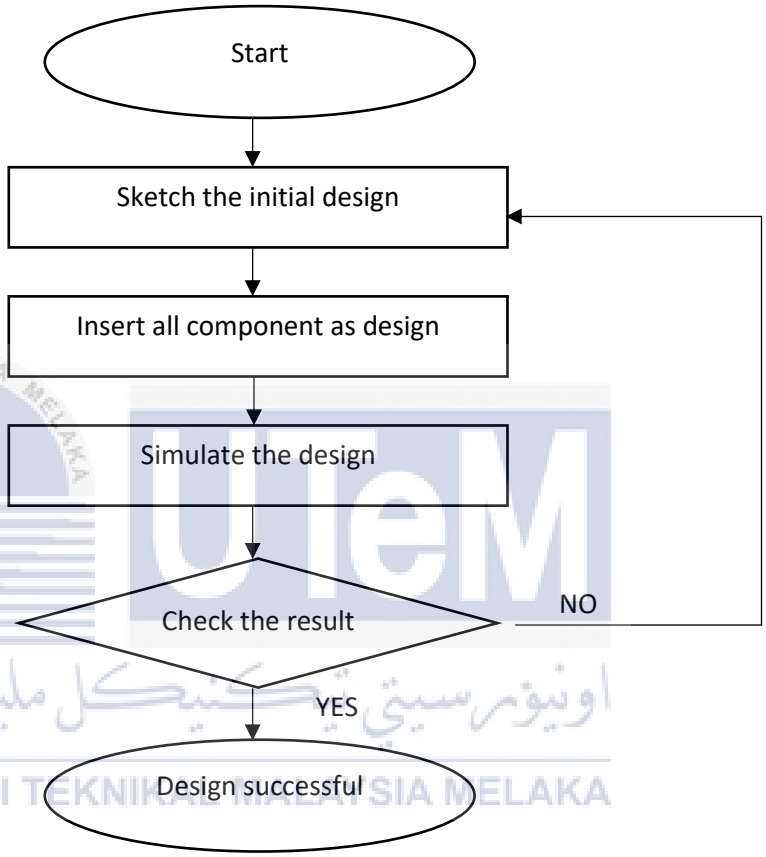


Figure 3.2: FluidSIM process flow

3.8 FABRICATION THE PRODUCT

The fabrication process that involve to manufacturing the product are wiring, cutting and connecting the hose and drilling. The fastener does not use for this project because it replaces with glue for stick the component at it place except for mount the cylinder to the wall. For bracket installation, it only use cable tie for temporary use only.

3.8.1 Wiring

The wiring process in this project is for connecting the electrical wire. The wire has three types which is life, neutral and earth. The life wire is brown colour,

neutral is blue colour and earth is green colour as shown in Figure 3.3. Then, the wire will connect to the socket and plug according to label at the back of socket and plug. To connect wire and wire, it uses wire connector as shown in Figure 3.4. The equipment needed for wiring proses is test pen and cutter. Function of test pen is for turn the screw and test the life wire. Cutter is for cut and strip the wire.

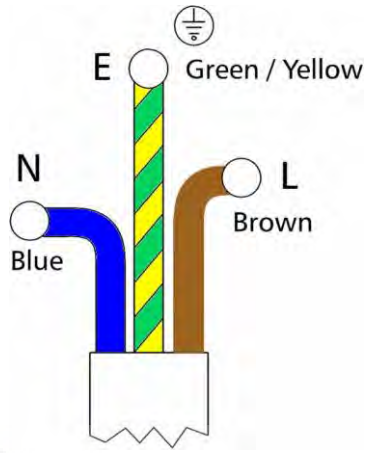


Figure 3.3: Wire colour code
(Source: unknown,nd)

Figure 3.4: Wire connector

3.8.2 Cutting and connecting the hose

This project fabrication need cutting and connecting process of ¼ inch water hose. The cutting proses use cutter as shown in Figure 3.5, it need to cut nicely to avoid any leakage when connecting the hose. Next, the hose will connect to T-joint and valve. to connect the hose with T-joint and valve, the blue lock need to remove as shown in Figure 3.6 and the hose will simply push to the hole. Then, to remove the hose the hose, remove the blue lock and push the outside are of the hole and pull the hose. Make sure the blue lock is attach when operate the system for prevent the water leakage.

Figure 3.5: Cutter

Figure 3.6: T-joint

Figure 3.7: Valve

3.8.3 Drilling

The drilling process involve in this project for connecting the cylinder to the wall. The machine use is impact drilling machine to make holes at the wall. Then, the cylinder will mount using metal ¼ inch wall plug to the wall as shown in Figure 3.8.

Figure 3.8: Wall plug

3.8.4 Control valve

The control valve used in this project is solenoid 2/2 way control valve and 4/2 way directional control valve. A solenoid 2/2 way valve as shown in Figure 3.9 is an electromechanically operated valve. The valve is controlled by an electric current or battery supply through a solenoid. The valve is normally closed and will open when the electric current flow. This valve will control the flow to double acting cylinder.

Figure 3.9: Solenoid Valve
(Source: Solenoid valve 12 volt,n.d.)

3.9 ANALYSE THE PERFORMANCE

The analysis of the performance will start will product testing. The test will be done by observing the movement of fence for open and close and monitor the time taken for open and close. The water pressure is directly taken from pressure gauge. The problem and data will be record. The next analysis is cost of all component for manufacturing the product. It

need to consider the total unit for a pair of swing gate components. Then, the operating cost consumption will be calculated. The consumption is including water and power. The tariff of consumption will be taken from Syarikat Air Melaka Berhad and Tenaga Nasional Berhad. Lastly, force analysis will make for finding the push and pull force.

3.9.1 Force analysis

The force will be divided into two type which is pull and push force. Normally the push force is higher than the pull force because the area in push area is greater than pull area. The pull area less than push because of the rod is attach at the push area. The formula for calculating the force is as below:

Push force formula,

$$F = \frac{P\ X\ \pi\ X\ b^2}{4}$$

Pull force formula,

$$F = \frac{P\ X\ \pi\ X\ (b^2 - d^2)}{4}$$

Where,

P = Pressure

b = Bore diameter

d = Rod diameter

3.9.2 Pressure

The main parameter of this project is the water pressure for make sure the cylinder can move accordingly. To measure the pressure, it directly taken from pressure gauge as shown in Figure 3.10. The unit of the pressure gauge is pound per square inch (PSI).

Figure 3.10: Pressure gauge

The pressure gauge will connect to the tap water as shown in Figure 3.11. Make sure there is no leakage because it can cause the pressure drop. The pressure gauge has small hole under the thread that connect to the pipe. Inside the hole have a sensor to measure the water pressure. The water will push the sensor and the reading will appear on the gauge meter.

Figure 3.11: Connecting the pressure gauge

3.10 COMPARE BETWEEN PRODUCTS

The comparison of the product will be carried out with this project with existing product. The comparison will be consisting of the component cost and the operating cost of this project. The existing product is taken from the market and will check the price and calculate the power consumption that used by the product for a month.

CHAPTER 4

DATA AND RESULT

4.1 INTRODUCTION

This chapter will explain about data and result of this project. It consists of house of quality, product design specification, conceptual design, Pugh method, simulation of selected concept, fabrication process and water pressure monitoring.

4.2 HOUSE OF QUALITY

Table 4.1: House of Quality

		Engineering Characteristic			
Improvement Direction		↓	↓	↓	↓
Units		m	RM	n/a	kg
Customer Requirements	Importance Weight Factor	Size	Component cost	Maintenance	Weight
Easy to use	5	1	9		1
Compact shape	3	9	3		9
Cheap	5	3	9	3	1
Long lasting	4		3	9	
Easy to install	3	3	3	9	9
Save space	4	9			
Raw Score		92	120	78	64
Relative Weight %		26.0	33.9	22.0	18.1
Rand Order		2	1	3	4

The highest engineering characteristic is component cost with 33.9% of relative weight. The component cost will affect the total cost of product and normally the cost of automatic fence system is expensive. It is crucial when the component required low cost but it should be high quality product. Therefore, selecting the suitable component is important to get the affordable component cost as the customer needs a cheap price of automatic fence system.

The least important of engineering characteristic is the weight with 18.1% of the relative weight. The weight is not important because the device does not move or portable. When it installed, the device only stays at one place and no need human energy to move the device.

4.3 PRODUCT DESIGN SPECIFICATION

1. Product identification

- Function: To open and close fence automatically
- Basic feature: Using hydraulic system and remote control

2. Environmental

- Temperature range: Room temperature

3. Physical description

- Compact shape
- Bracket for wall mount

4. Market Identification

- Target: housing area

5. Financial requirement

- Target price: RM 800

6. Life cycle Targets

- Service life: 10 years
- Maintenance: Minimal
- Reliability: Maximum 3% failure rate over service life

7. Safety

- Maintain the device with care
- Protect all electrical assemblies against wet, moisture and dust

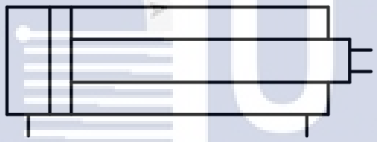
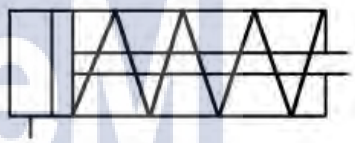
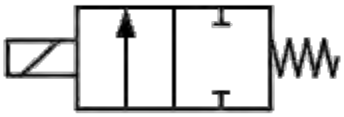
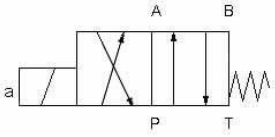
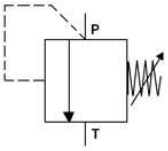
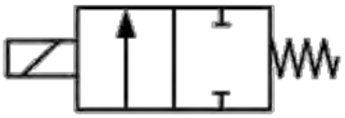
4.4 CONCEPTUAL DESIGN

For generate the idea, the morphological chart was used by listing all selected component for produce the product. Then, all the component will choose correctly according to their function and features. Five concept had been created from the morphological chart. Using Pugh method, the concept evaluated and choose the best concept.

4.4.1 Morphological chart

Morphological chart is the method to provide ideas with analytical and systematic way. It usually starts with function of the product and solutions. The solution is the component that possible to used according to the same function.

Table 4.2: Morphological Chart

FUNCTION	OPTION 1	OPTION 2
Cylinder	 Double Acting Cylinder	 Single Acting Cylinder with spring
Control Valve	 2/2 Way Solenoid Valve	 4/2 Way Solenoid Valve
Relief Valve	 Pressure Relief Valve	 2/2 Way Solenoid Valve

From morphological chart, the three main function was selected which is cylinder, control valve and release valve. The option of cylinder are double acting cylinder and single acting cylinder with spring return for moving the fence. Then, for control the flow, solenoid 2/2-way and solenoid 4/2-way was used. Lastly, relief valve are pressure release valve and solenoid 2/2-way valve had been selected. From the following choices, five concepts had been generated based of solution given.

4.4.2 Concept 1

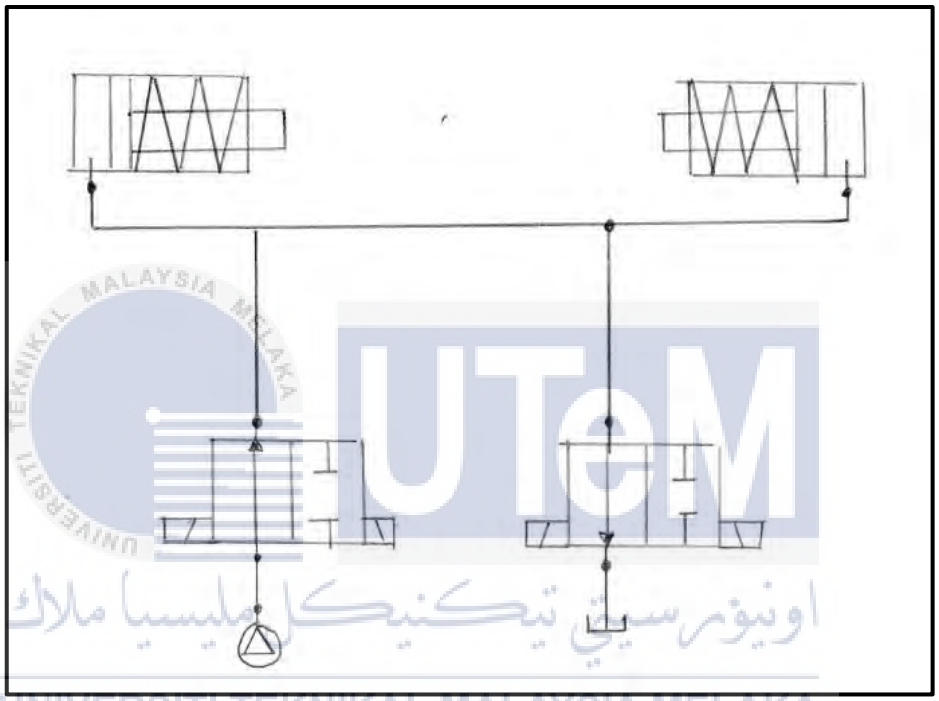


Figure 4.1: Concept 1

Concept 1 used two single acting cylinders with spring return as cylinder, solenoid 2/2-way valve as control valve and relief valve. To extend the cylinder, the fluid will flow through control valve when the solenoid activates. Then, to retract the cylinder, the release valve will activate and the spring will push the cylinder. The fluid will flow through the release valve. The problem in this system when the spring failure and the cylinder cannot retract to initial position. The advantages of this system are the system use less component and the component is cheap. It also cannot extend the cylinder when the fluid pressure is lower than spring pressure. Table 4.3 shows the estimate price of concept 1.

Table 4.3: Estimate price for main component concept 1

Component	Unit	Price per unit (RM)	Total Price (RM)
Cylinder	2	300	600
Control Valve	1	30	30
Relief Valve	1	30	30
		Total	660

4.4.3 Concept 2

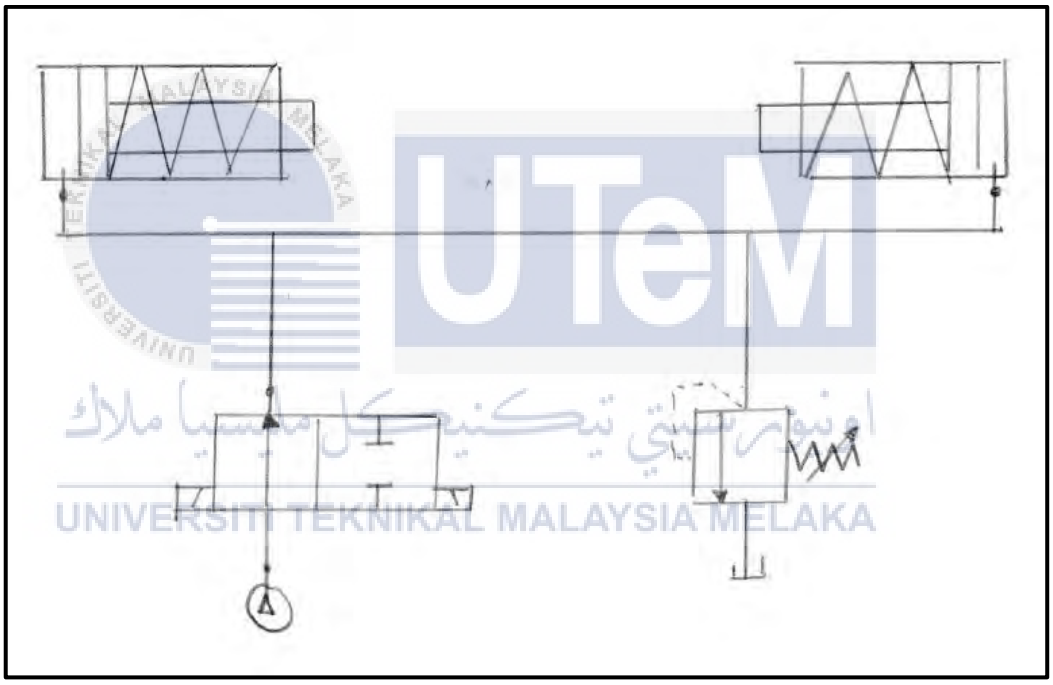


Figure 4.2: Concept 2

Concept 2 used two single acting cylinders with spring return as cylinder and 2/2-way valve as control valve same with concept 1 but for the relief valve, it used pressure relief valve. To extend the cylinder, the fluid will flow through control valve when the solenoid activates. Then, to retract the cylinder, the spring will automatically push the cylinder and the fluid will flow through pressure relief valve. This system is fail because when the flow to extend the cylinder, the pressure need greater than pressure of spring. It makes the relief valve always open because the pressure of relief valve should be lower than the spring and it cause the cylinder cannot extend. The advantage is the system use pressure relief valve that can protect

the system from damage especially cylinders' part. Table 4.4 shows the estimate price of concept 2.

Table 4.4: Estimate price for main component concept 2

Component	Unit	Price per unit (RM)	Total Price (RM)
Cylinder	2	300	600
Control Valve	1	30	30
Relief Valve	1	130	130
		Total	760

4.4.4 Concept 3

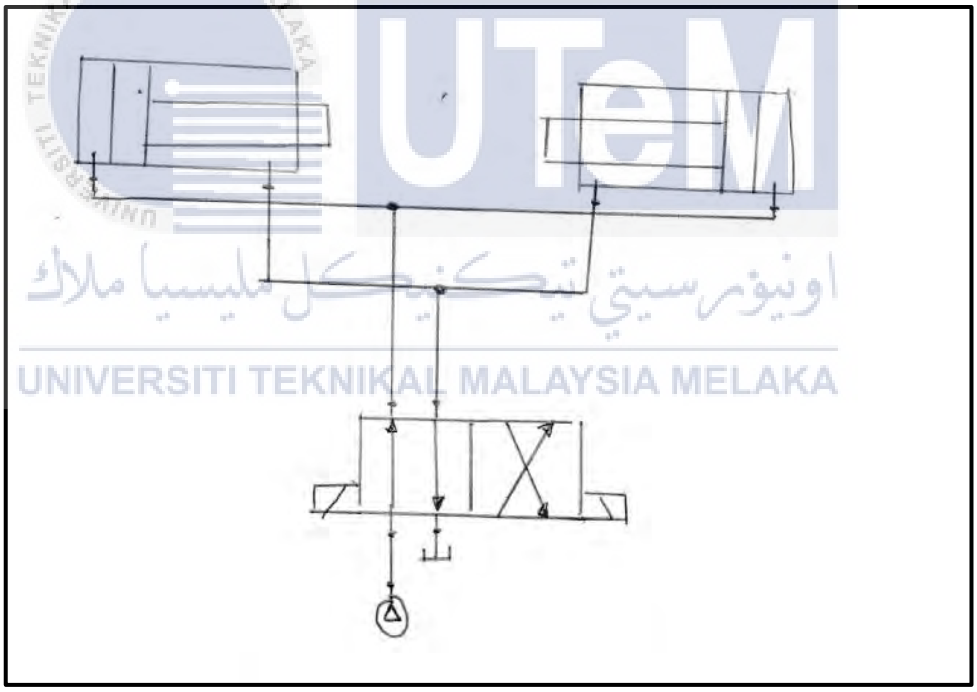


Figure 4.3: Concept 3

Concept 3 used two double acting cylinders as cylinder and a solenoid 2/4-way control valve as control valve and relief valve. To extend the cylinders, the solenoid will activate and the fluid will flow through the control valve. To retract the cylinders, the solenoid will activate and the room control valve will change the direction of fluid flow. The directional control valve used in this system is quite expensive and it's hard to find in the market for maintenance or replacement. the

advantage is the system only use one control valve which it helps in manufacturing ease. Table 4.5 shows the estimate price of concept 3.

Table 4.5: Estimate price for main component concept 3

Component	Unit	Price per unit (RM)	Total Price (RM)
Cylinder	2	280	560
Control Valve	1	250	250
Relief Valve	-	-	-
		Total	810

4.4.5 Concept 4

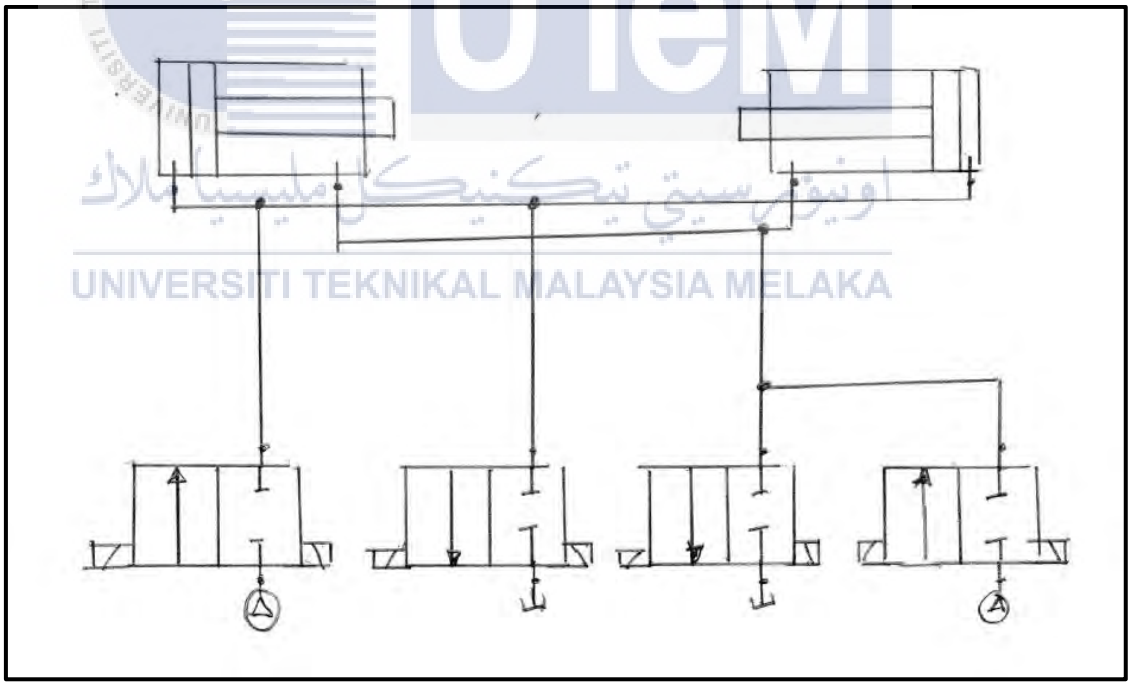


Figure 4.4: Concept 4

Concept 4 used two double acting cylinders as cylinder and four solenoid 2/2-way control valve as control valve and relief valve. To extend the cylinders, the two 2/2-way control valve used to operate the system. One control valve for flow the fluid from supply and one control valve for water outlet. To retract, the same operation

was used using two different control valve. Then, after finish the operations, all the solenoid will be deactivating to cut the flow. In this system, the used many component and need to consider the size of the device but it is easy to maintain and manufacturing. Table 4.6 shows the estimate price of concept 4.

Table 4.6: Estimate price for main component concept 4

Component	Unit	Price per unit (RM)	Total Price (RM)
Cylinder	2	280	560
Control Valve	2	30	60
Relief Valve	2	30	60
		Total	720

4.4.6 Concept 5

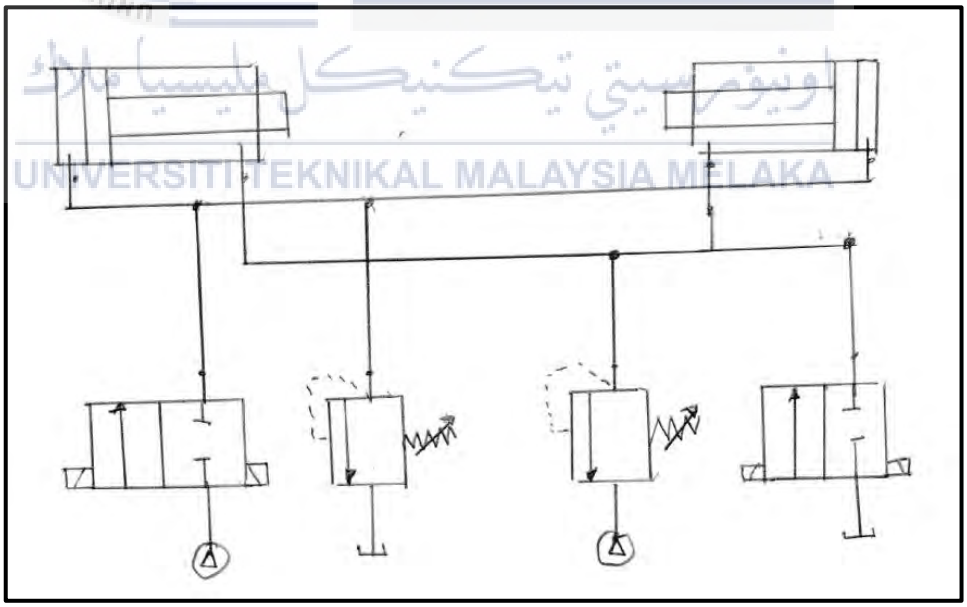


Figure 4.5: Concept 5

Concept 5 used two double acting cylinders as cylinder, two solenoid 2/2-way control valve as control valve and two pressure relief valve as relief valve. To extend the cylinders, the solenoid will be activating the 2/2-way control valve. It open flow of the fluid to cylinder, then the fluid from cylinder will flow to pressure

relief valve to the outlet. It same for retract operation of cylinders. The pressure relief valve has some problem when the pressure of water supply is decrease or increase and it cause the valve not working. The advantage is same with concept 2, the system use pressure relief valve that can protect the system from damage especially cylinders' part. The pressure setup is normally in manual mode. Table 4.7 shows the estimate price of concept 5.

Table 4.7: Estimate price for main component concept 5

Component	Unit	Price per unit (RM)	Total Price (RM)
Cylinder	2	280	560
Control Valve	2	30	60
Relief Valve	2	130	160
		Total	820

4.5 PUGH METHOD

Pugh concept selection is usually used in engineering for selecting the design. It is consisting several criteria which are safety, environment, reliability, durability, cost, ease of replacement and ease of setup. Based on table 4.8, concept 4 getting the highest rating compared to another concept and automatically concept 4 had been choose for selected concept.

Table 4.8: Pugh method

Concept		Datum	1	2	3	4	5
Criteria	Weight						
Safety	2	0	0	+	0	0	+
Environment	2	0	0	-	0	0	-
Reliability	2	0	0	-	+	+	0
Durability	2	0	-	-	-	-	-
Cost	3	0	+	+	+	+	+
Ease of replacement	2	0	+	+	+	+	+
Ease of setup	3	0	0	-	0	0	-
+		0	5	7	7	7	7
0		16	9	0	7	7	2
-		0	5	12	5	2	10
Net Score		0	0	-5	2	5	-3

Based on the Pugh analysis method, the concept 4 getting the better criteria on the reliability, cost and ease of replacement. The reliability is depending on the simulation that show the system is working in good condition. From the cost, the expected cost is lower than the existing automatic fence. The component also easy to find, so it scores on the ease of replacement. Concept 2 is the lowest score because it only gets the better criteria on safety, cost and ease of replacement. It uses pressure relief valve for safety and it also use common component for replacement.

4.6 SIMULATION OF SELECTED CONCEPT

After choosing the concept, the simulation need to be done before fabrication process. It is to confirm that the system can run in good condition. This simulation had been tested using FluidSIM software. The result for simulation is successful and all the component functioning as planned. Figure 4.6 shows the system at rest and all the flow was closed. Then, for extend operation, solenoid SOL 1 was activated according to figure 4.7. Lastly, activation of solenoid SOL 2 cause the cylinder retract to initial position as shown in figure 4.8.

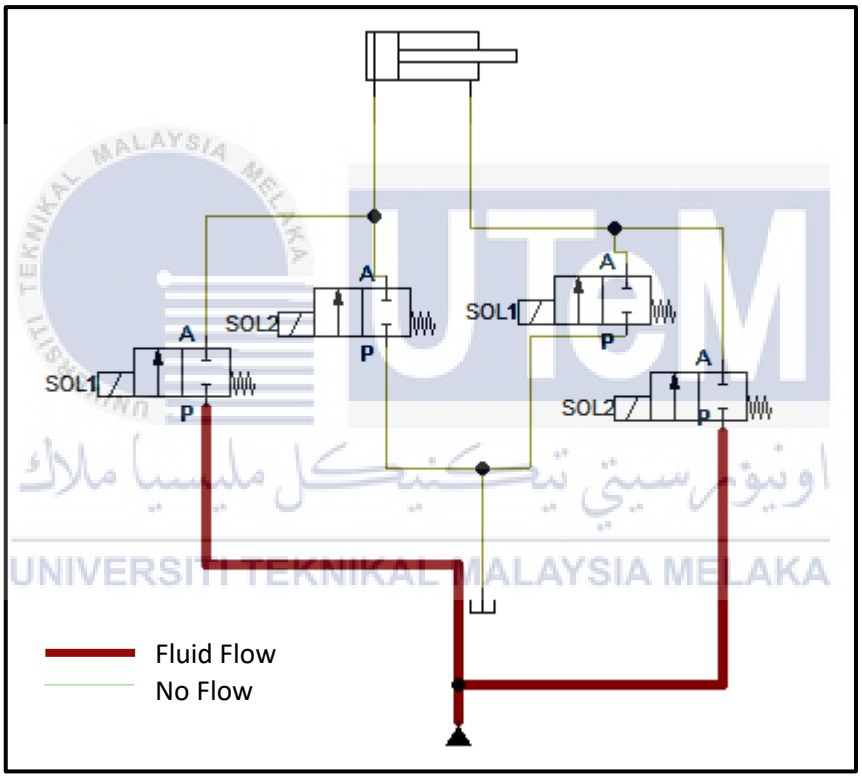


Figure 4.6: System at rest position

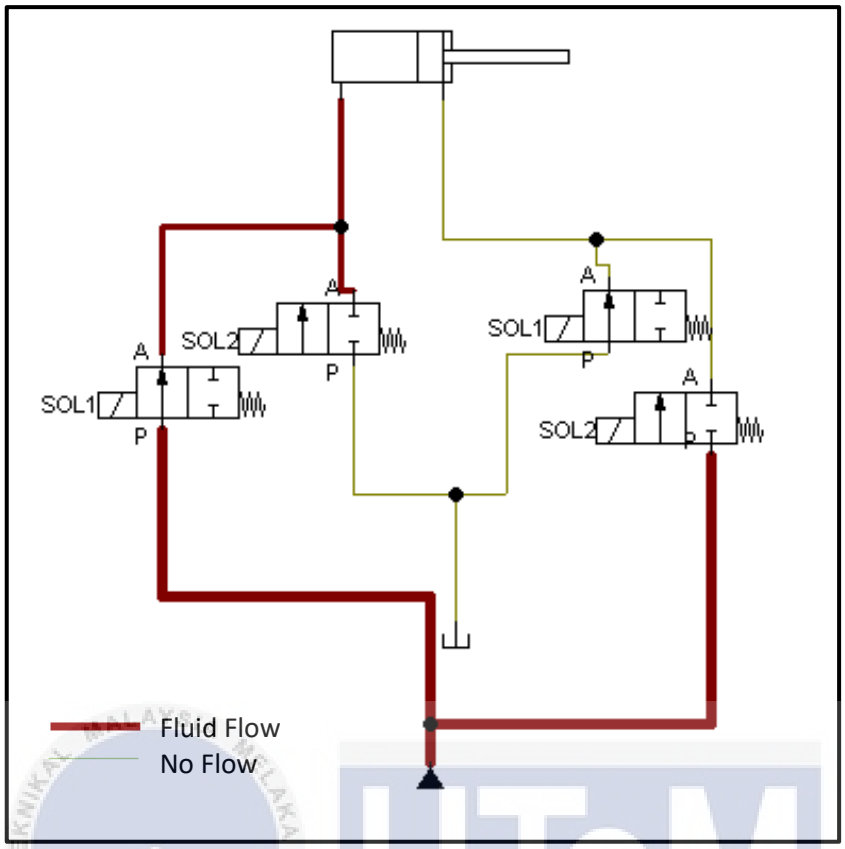


Figure 4.7: System extend operation

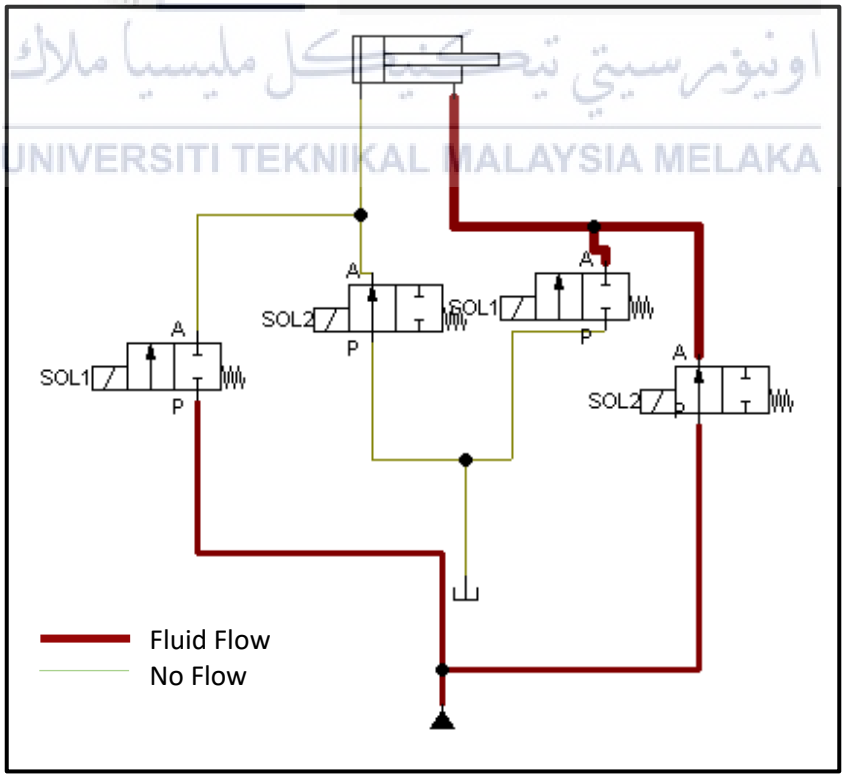


Figure 4.8: System retract position

4.7 FABRICATION PROCESS

The fabricating proses was focused on concept 4 and the process starting with searching for all components. Some components were taken from last year undergraduate project student. The components were listed in Table 4.9 and as shown in Figure 4.9.

Table 4.9: Available components list

No	Component	Quantity
1	Double acting cylinder	1 unit
2	Fence bracket	1 unit
3	Valve	1 unit

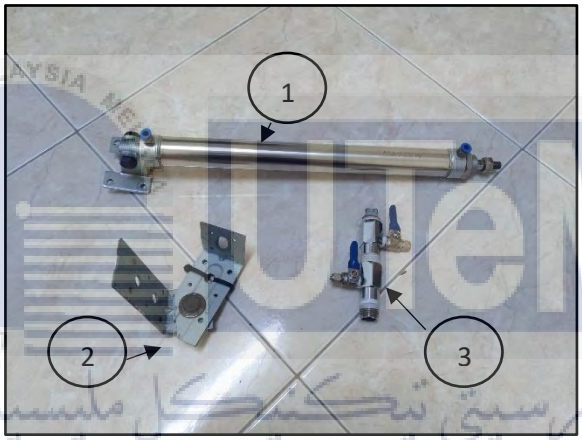


Figure 4.9: Available components

For completing the fabrication proses, the new components need to buy according their specification and quantity. The component was from local and overseas online shop and hardware shop. The components were listed in Table 4.10 and as shown in Figure 4.10.

Table 4.10: New components list

No	Component	Quantity
1	Flexible hose ¼”	15 metre
2	Solenoid valve 12V (2/2 way)	4 units
3	Hose connector	1 set
4	Power adapter DC 12V 1.25A	2 units
5	T joint stop cock ¼”	4 units

6	Extension wire	1 unit
7	Water pressure gauge	1 unit
8	220V 3-way digital remote control	1 unit
9	Socket	2 units
10	Plug	1 unit
11	Socket housing (3 socket set)	1 unit
12	Wire	5 metre
13	Wire connector	1 set
14	Box	1 unit
15	Wall plug	4 units

Figure 4.10: New components

After all the component was completed, the fabrication process started with setup the control panel. The manual for connecting the digital remote control was shown in Figure 4.11. The digital remote control was connected to socket and all connection was connected according specification as shown in Figure 4.12. The digital remote control will control the current flow to the socket and power adapter was attached to it.

Figure 4.11: Manual of digital remote control

Figure 4.12: Wiring of socket

After finish the control panel, the fabrication process continues with solenoid valve assembly. The flexible hose was measured and cut to its dimension. The solenoid valve has arranged and connected with flexible hose according to FluidSIM simulation software as shown in Figure 4.13.

Figure 4.13: Valve circuit

The hydraulic circuit had been attached to the box for easy to carry and protect the equipment from damage. Then, the hydraulic circuit will have connected to power adapter as shown in Figure 4.14. The power adapter had been connected to control panel as shown in Figure 4.15.

Figure 4.14: Power adapter wiring

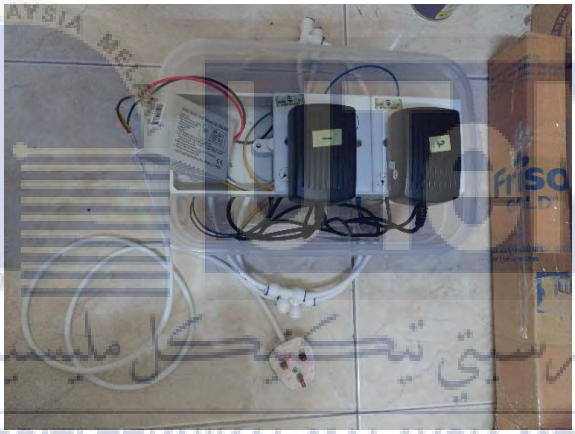


Figure 4.15: Power adapter to socket

Lastly, the bracket for connecting the double acting cylinder to the fence has been attached using cable tie to reduce damage at the fence as shown in Figure 4.16. For this project, the fence of my rental house was selected for testing area. Then, the double acting cylinder connected to the wall using wall plug as shown in Figure 4.7. The final assembly of bracket and double acting cylinder as shown in Figure 4.18.

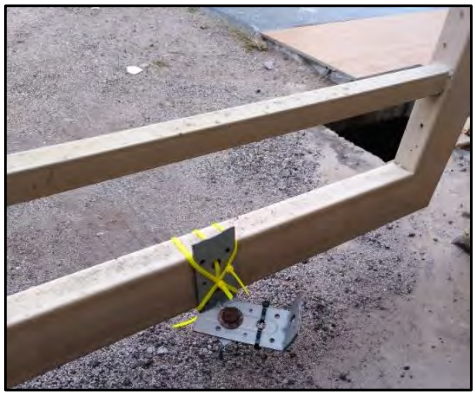


Figure 4.16: Bracket installation

Figure 4.17: Cylinder wall mount

Figure 4.18: Cylinder installation

4.8 WATER PRESSURE MONITORING

After completing the fabrication process, the water pressure had been monitored for one week to observe the pressure change. The test has been done at Taman Enggang, Durian Tunggal for 3 times per day as shown in Table 4.11. the highest daily average pressure is 43 psi on Tuesday and the lowest is 41 psi on Friday. Then, the highest average pressure is at the evening and the lowest is at the morning. The highest average pressure on evening maybe cause by majority of house residents working and not at home and the morning shows the lowest pressure cause by the house residents use water to getting ready for going to work.

Table 4.11: Pressure daily monitoring

DAY	MORNING (PSI)	EVENING (PSI)	NIGHT (PSI)	DAILY AVERAGE (PSI)
MONDAY	38	44	46	42.7
TUESDAY	38	45	46	43.0
WEDNESDAY	35	45	45	41.7
THURSDAY	35	45	44	41.3
FRIDAY	40	45	38	41.0
SATURDAY	33	45	46	41.3
SUNDAY	35	44	45	41.3
AVERAGE PRESSURE (PSI)	36.3	44.7	44.3	

From Figure 4.19, the maximum pressure is 46 psi at night because the user is less at night. The minimum water pressure is 33 psi on Saturday morning, the pressure drop is start on Friday night because the user start to use water for washing their cloth or house.

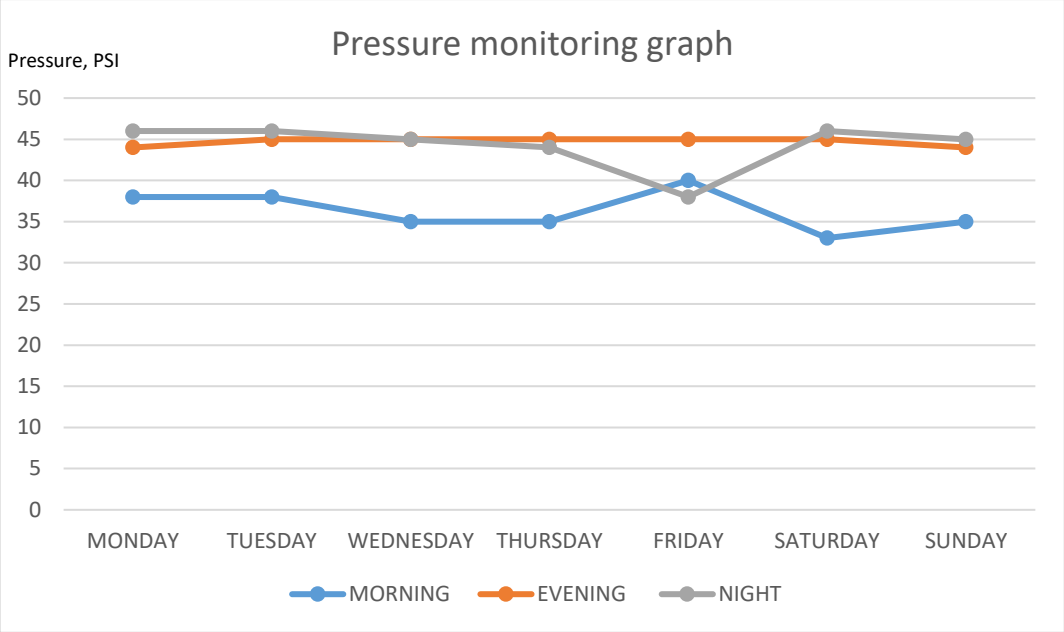


Figure 4.19: Pressure graph

CHAPTER 5

DISCUSSION AND ANALYSIS

5.1 INTRODUCTION

This chapter will explain about discussion and analysis of this project. The analysis involved in this project are product testing, component cost, water consumption, power consumption, force analysis, comparison between existing product and potential of commercialization.

5.2 PRODUCT TESTING

After completing fabrication proses of each part, all parts will assemble as shown in Figure 5.1 for product testing. In overall, the testing was run smoothly and successful as planned. The fence can be open and closed automatically. The problem occurs when the fence cannot close from the open position because of the angle of the fence as shown in Figure 5.2. After investigation with supervisor, the bracket need to be improve by increase the length for reduce angle of the piston.

Figure 5.1: Full assembly

Figure 5.2: Bracket problem

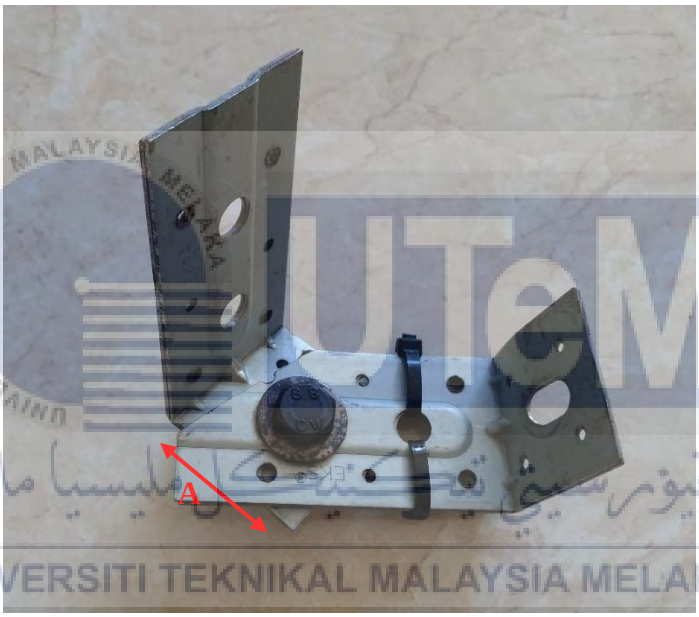


Figure 5.3: Bracket

From Figure 5.3, the dimension A need to extend for reduce the angle of cylinder when the fence in open position. The material of existing bracket also need to improve because it easy to bend. Therefore, the thickness of the bracket should be increase for making the strength higher. For suggestion, the metal plate with greater than 10mm thickness is suitable and it will use welding process to make the bracket. In next research, the stress need to calculate in theory to get the safety factor before fabricate the bracket.

5.3 COMPONENT COST ANALYSIS

The components cost consist of all components that need to use for manufacturing for a pair of swing. The Table 5.1 shows the total cost of components for manufacturing the product. The total components cost is RM 821.85. The highest component price is double acting cylinder and it need two unit for a pair of swing type fence. This components cost can be reduced if all components are purchased in bulk. The target of the reducing price can be until 50 percent from this price.

Table 5.1: Component cost

Component	Quantity	Price per unit (RM)	Price
Double acting cylinder	2 unit	280.00	560.00
Fence bracket	2 unit	10.00	20.00
Flexible hose ¼”	5 metre	1.87	9.35
Solenoid valve 12V (2/2 way)	4 units	30.00	120.00
Power adapter DC 12V 1.25A	2 units	20.00	40.00
T joint stop cock ¼”	4 units	4.50	18.00
220V 3-way digital remote control	1 unit	33.50	33.50
Socket	2 units	4.00	8.00
Plug	1 unit	4.00	4.00
Socket housing (3 socket set)	1 unit	5.00	5.00
Wire	2 metre	2.00	4.00
Total			821.85

5.4 WATER CONSUMPTION

This project use water pressure to extend and retract the cylinder and the water inside the cylinder will flow out of the cylinder for every usage as shown in Figure 5.4. The water will flow through outlet water hose. Table 5.2 shows the water consumption of this project.

Figure 5.4: Water consumption per usage

Table 5.2 shows the water consumption for each open and close operation and for one and two cylinder. The total water consumption for one cylinder is 0.45 litre and two cylinder is 0.9 litre for open and close operation. From the water consumption, the price can calculate. Table 5.3 shows the water tariff for Syarikat air Melaka Berhad.

Table 5.2: Water consumption table

Description	**One cylinder (litre)**	**Two cylinder (litre)**
Open (extend)	0.25	0.5
Close (retract)	0.2	0.4
Total water consumption	0.45	0.9

Table 5.3: Water tariff

USAGE (m^3)	**PRICE (RM)**
20	0.60
15	0.95
10	1.45

From Table 5.3, the price for water consumption per month can calculate as below:

Water consumption = 0.9 litre (for a pair of swing fence)

Water tariff = RM 0.60 / m^3

Assumption usage per day = 10 times

Calculate litre per day,

$$0.9 \text{ L X } 10 = 9.0 \text{ L / day}$$

Calculate litre per month,

$$9.0 \text{ L / day X } 30 \text{ days} = 270 \text{ L / month}$$

Price per month,

$$1m^3 = 1000 \text{ L}$$

$$\frac{270}{1000} L \; X \; RM \; 0.60 = \boldsymbol{RM \; 0.162 \; per \; month}$$

5.5 POWER CONSUMPTION

This project use electricity for activate the solenoid valve to make this system can control using remote control. The power can be of the system can be calculate using formula work done per unit time.

$$P = VI$$

Where,

P = power (watts)

V = voltage (volts)

I = current (amperes)

The parameters for this project are,

V = 12 Volts

I = 1.25 Amperes

Calculate power,

P = 12 Volts X 1.25 Amperes

P = 15 Watts

Duration for open and close the fence = 30 seconds

Assumption usage per day = 10 times

Electric tariff = RM 0.218 / kWh

Calculate duration per day,

30 s X 10 times = 300 s/day or 5 minutes/day

Calculate duration per month,

5 minutes x 30 days = 150 minutes/month or 2.5 hours/month

Calculate price per month,

15 watts = 0.015 kW

2.5 hours X 0.015 kW = 0.0375 kWh/month

0.0375 kWh X RM 0.218 = **RM 0.008 per month**

5.6 FORCE ANALYSIS

This analysis is about calculating force that can be push or pull by the cylinders. The water pressure that use for calculation are maximum pressure and two different location water pressure and different type of fence. The maximum water pressure is the pressure that valve can hold and if the pressure is greater than that, the valve might be damage. Another two pressure is taken from different location which is 20 psi and 40 psi. The pressure was directly taken from pressure gauge.

Push force formula,

$$F = \frac{P\ X\ 3.1415\ X\ b^2}{4} lbs$$

Pull force formula,

$$F = \frac{P\ X\ 3.1415\ X\ (b^2 - d^2)}{4} lbs$$

Where,

b = Bore diameter

d = Rod diameter

The parameter for this project are,

b = 32 mm or 1.25984 inch

d = 12 mm or 0.472441 inch

The weight of two type was measured using CATIA software by redraw the fence according to the dimensions. Figure 5.5 and Figure 5.6 show the mass properties of both type of fence.

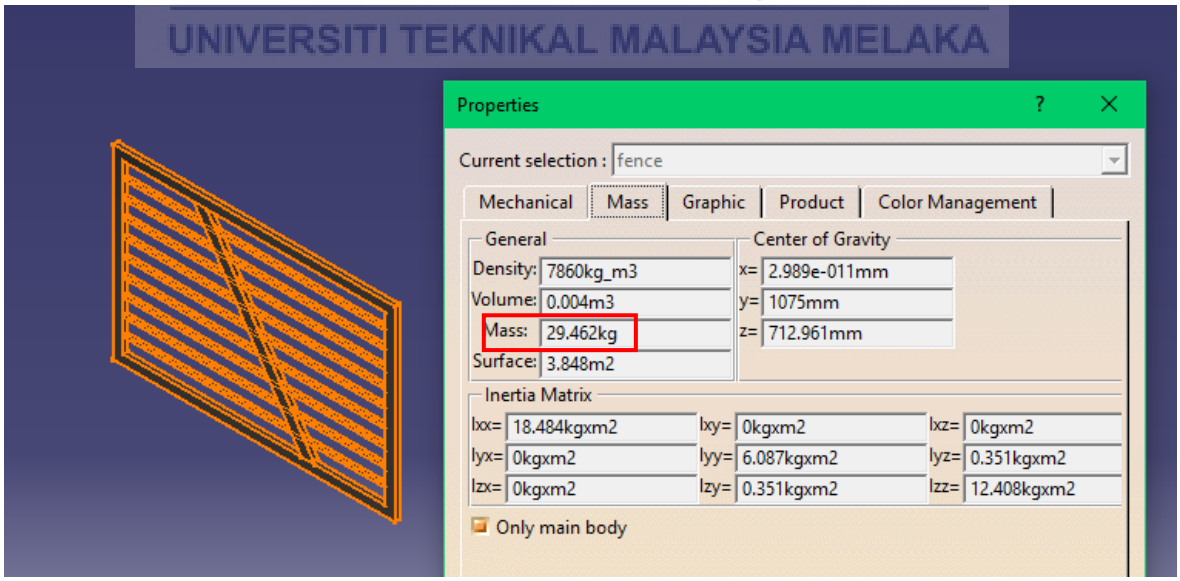


Figure 5.5: Swing type fence mass

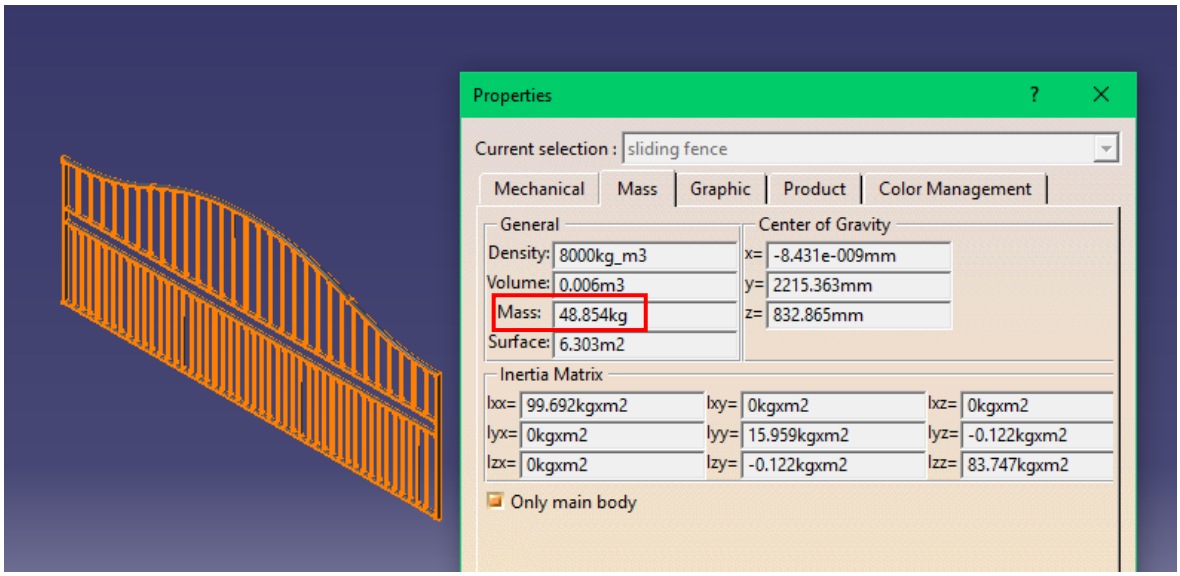


Figure 5.6: Sliding type fence mass

Table 5.4: Push force

Description	Pressure (psi)	Force (lbs)	Force (kN)	Weight (kg)	Fence weight (kg)
Max. pressure	116	144.6	0.64	65.2	-
Swing fence	40	49.86	0.22	22.4	29.5
Sliding fence	20	24.93	0.11	11.2	48.9

Table 5.5: Pull force

Description	Pressure (psi)	Force (lbs)	Force (kN)	Weight (kg)	Fence weight (kg)
Max. pressure	116	124.26	0.55	56.1	-
Swing fence	40	42.85	0.19	19.4	29.5
Sliding fence	20	21.42	0.1	10.2	48.9

5.7 COMPARISON BETWEEN EXISTING PRODUCT

The cost of this project and operating cost will be compare to the existing product. The total of component cost will have compared to the existing product. The operating cost is total of water consumption and power consumption price per month.

5.7.1 Product price comparison

Table 5.6 show the comparison price between this project local product and overseas product. This project is the lowest price between another two products because this project use low price components.

Table 5.6: Price comparison

This project	Local product	Overseas product
RM 821.25	RM 1450 (Source: Dc Motor 925W Hybrid Auto gate.n.d.)	RM 1438.05 ($329.51) (Source: eBay.n.d.)

5.7.2 Operating cost comparison

The existing product that chosen for operating cost comparison is the local product. It uses DC motor with 925 watts power. The calculation of power consumption of existing product as below:

925 watts = 0.925 kW

2.5 hours X 0.925 kW = 2.3125 kWh/month

2.3125 kWh X RM 0.218 = **RM 0.504 per month**

Calculate the total operating cost of this project,

RM 0.162 + RM 0.008 = **RM 0.17 per month**

From Table 5.7 shows the operating cost of this project and existing product and this project operating cost is lower than the existing product that use DC motor to operate. The cost is less than 50 percent save than the existing product.

Table 5.7: Operating cost per month

This project cost per month (RM)	Existing product cost per month (RM)
RM 0.17	RM 0. 504

5.8 POTENTIAL OF COMMERCIALIZATION

The target market of this project is Perumahan Rakyat 1Malaysia (PR1MA) as shown in because it is low cost house and to reduce the cost of the house, it can use this project product for automatic fence system. The sample of house as shown in Figure 5.7, most PR1MA house use swing type fence. PR1MA house planned to build 80 000 unit house per year to meet the vision of one million affordable house (Kerajaan Nafi Naikkan Harga Rumah Prima,2015). If the target market for using this product is 30 percent per year from the total unit amount, the total selling can reach until 19 million Ringgit Malaysia.

Figure 5.7: PR1MA house
(Source: Kerajaan Nafi Naikkan Harga Rumah Prima,2015)

CHAPTER 6

CONCLUSION AND RECOMMENDATION

In conclusion, the main finding of this project is the total cost and the operating of this project is lower than existing product. The product is used for swing type of fence and it had been tested at Taman Enggang, Durian Tunggal. The result of the testing is successful because the double acting cylinder work as simulated.

The objective of this project was achieved because the of design for existing hydraulic fence product has been improved by using water pressure and automatic remote control. The water pressure does not need additional water pump to increase the pressure. From monitoring the water pressure, the minimum pressure was 33 psi and it able to move the common swing type fence with the weight of 30 kg. Then, the manufacturing of the product is done successfully. The main component of this project is double acting cylinder, solenoid valve and remote control switch. The manufacturing process is also easy because it does not need any special tool to build the product. Lastly, the product had been compared to existing product to compare the cost and the consumption.

The recommendation of this project is adding the safety features on the hose such as metal cover to avoid the system easily to bypass. Then, the case of main component also need to redesign to make the product aesthetic increased. Next, for making the product zero power consumption, solar panel and battery can be added. The waste water also can be used for watering the plant. The outlet of water can be put at the plant and it indirectly function as automatic watering system when the fence is open. Lastly, this project had been tested on sliding fence as shown in Figure 6.1 and it able to push and pull the fence. To apply this system on sliding fence is not suitable because it will need very long cylinder, but the cylinder can change to hydraulic motor to move the sliding fence.

Figure 6.1: Sliding fence assembly

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